BULLETIN

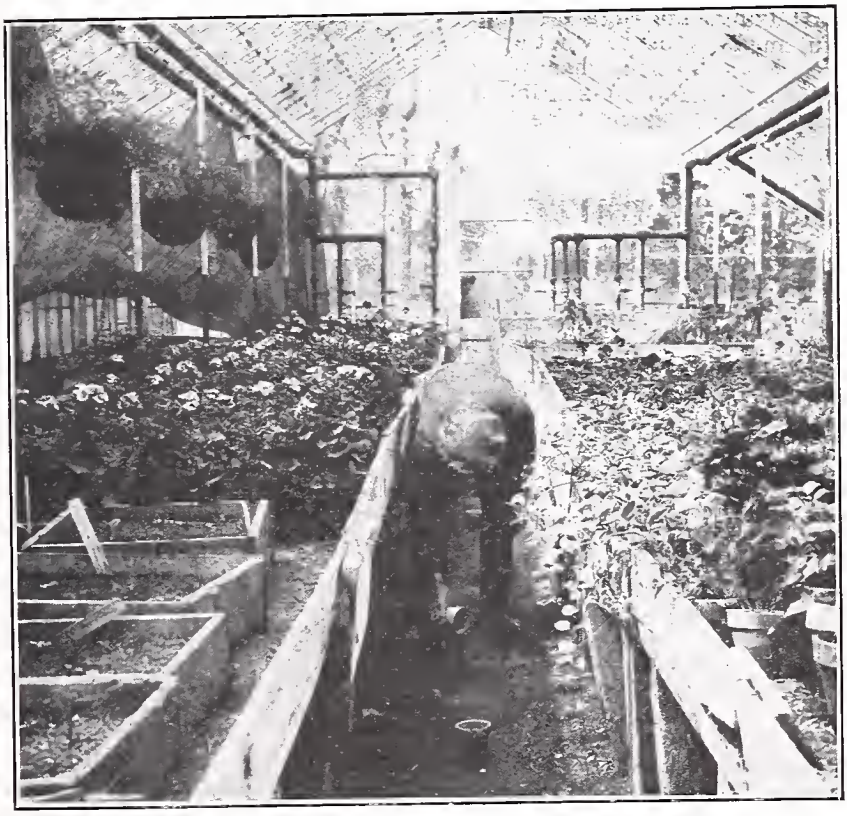
Pennsylvania Department of Agriculture

HARRISBURG

Vol. 8 October 1, 1925 No. 17

Greenhouse Fumigation

General Bulletin No. 413



Placing Calcium Cyanide in Greenhouse for Fumigating to Control Insects

F. P. WILLITS, *Secretary of Agriculture*
C. H. HADLEY, *Director, Bureau of Plant Industry*

Published semi-monthly by direction of the Secretary. Entered as second class matter, March 22, 1918, at the Post Office at Harrisburg, Pa., under the Act of June 6, 1900. Acceptance for mailing at special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized on June 29, 1918.

SUMMARY

A survey of greenhouses in Pennsylvania shows nearly all suffer severe losses from insects. Plant lice were present in most of the houses visited and twenty-two other pests were reported present in harmful numbers in some houses.

Calcium cyanide (a new material) offers cheap and effective fumigation for greenhouses.

For success with calcium cyanide fumigation the following steps must be observed.

1. Calculate accurately the cubic space of your greenhouse. (See page 5.)

2. Be sure your house is free from plants which are especially susceptible to injury from fumes of cyanide. (See page 4.)

3. Accurately weigh out the amount of material needed. Start with one-eighth ounce to 1000 cubic feet. If your house is fairly tight this dosage will be sufficient.

4. Always start the fumigation about one hour after sundown—never before. Choose a still night.

5. Do not water the greenhouse for at least twenty-four hours before fumigation.

6. The temperature should be between 55 and 70 degrees Fahr., and it should be a rising temperature.

Greenhouse Fumigation

By T. L. Guyton, *Bureau of Plant Industry.*

CONTENTS

GREENHOUSE INSECT PESTS

A recent survey made by the Pennsylvania Department of Agriculture through the Bureau of Plant Industry showed the greenhouse growers of the state are confronted with a heavy loss at all times due to the insect pests of the plants grown under glass. It is not the purpose of this bulletin to discuss all these pests and their control, but it seems well at this point to present briefly some of the more outstanding facts shown by the survey.

A total of 413 greenhouses were visited, located in 18 counties of the state. Loss by insects was evident in all of the houses—if not directly by the ravages of the pests, then by the labor and cost of materials used in controlling the pests. Complete or satisfactory control of all pests was evident in but few of the houses; in these cases the loss occasioned by the pests themselves was reported as practically nil.

It is interesting to note that plant lice or aphids were present in a larger number of houses than any other single group of insects, the number being 302 houses out of the total. Red spiders were present in 197 houses; white flies, 108; greenhouse leaf tiers, 81; chrysanthemum gall midge, 57 (practically all houses growing chrysanthemums); mealy bugs, 42; sow bugs, 42; and so on through a list of twenty-three pests or groups of pests, each greenhouse crop being attacked by its own particular pest.

The survey showed the use of several remedies by the greenhouse men for a particular pest. Many of these remedies are patent or trade preparations—some of which sell at rather exorbitant prices, and all of which depend upon a few basic compounds for their worth as insecticides. It seems evident that quite a saving would result to the growers if more attention was paid to the selection of insecticides and the timeliness of application. Orchard men of the state have learned this lesson and are now buying only the basic materials needed in their spray pro-

grams and making the dilutions and mixtures in the orchard, saving in both money and time, and with the added security of having applied the right mixture at the right time.

BASIC MATERIALS USED IN FUMIGATION

Two basic materials are used in greenhouse fumigation: nicotine from tobacco, and hydrocyanic acid gas.

The nicotine from tobacco is used either from the tobacco plant itself in the form of a smudge made from the entire plant or some part of the tobacco plant; or a nicotine extract from the tobacco plant. In any case the nicotine is the killing agent, killing the insect through the breathing organs. Probably the cheapest form of nicotine to be used as a smudge is the entire or parts of the tobacco plant, though so-called "free" nicotine is successfully used as a smudge. The extract is usually found on the market in the form of nicotine sulfate which contains forty per cent nicotine, or "free" nicotine. The nicotine sulfate may be used for all sprays calling for nicotine and the "free" nicotine where a volatile nicotine is needed.

Hydrocyanic acid has been used for some time in greenhouse fumigation. This acid is a gas under ordinary conditions. It may be generated by placing either sodium or potassium cyanide in a solution of sulfuric acid. This method of securing hydrocyanic acid liberates a large volume of the gas in a comparatively short time and in greenhouse fumigation this heavy concentration at times caused considerable damage to the plants in the house.

Recently a material known as calcium cyanide has appeared on the market. This form of cyanide slowly undergoes a change in the presence of air liberating hydrocyanic acid gas and leaving a residue consisting mostly of air-slacked lime.

CALCIUM CYANIDE IN GREENHOUSE FUMIGATION

The use of this material as the source of hydrocyanic acid in greenhouse fumigation for the control of greenhouse insect pests has been developed by the Bureau of Entomology, United States Department of Agriculture in cooperation with the Bureau of Plant Industry, Pennsylvania Department of Agriculture.

In experimental work carried on in greenhouses in the vicinity of Philadelphia satisfactory control of aphids and white-fly and promising indications of control of other pests were obtained. This Bureau has sent out letters of inquiry to several greenhouse owners and managers to gather what their experience has been with the use of calcium cyanide. The replies indicate that with

but few exceptions the growers are getting good results with this material.

One grower suffered severe injury to sweet pea plants by an overdose of the material. Another grower made the mistake of doing the work in daylight, He, too, experienced injury to his plants.

Plants Killed or Injured by Cyanide. Asparagus plumosus, snap dragon, sweet pea and marguerite are often injured by very slight doses of cyanide and they should not be included in houses to be fumigated. Any other plants known to be especially susceptible to cyanide injury should be removed, if possible, from the house before fumigation.

Plants Successfully Fumigated With Cyanide. The experiments at Willow Grove, Pennsylvania, include fumigation of the following plants without injury, using as much as one-fourth ounce dose to each 1000 cubic feet:

Acalypha, achyranthes, ageratum, anthericum, aster, begonia, calendula, carnation, centaurea, chrysanthemum, citrus (grapefruit), coleus, cuphea, **Dicentra spectabilis, Didiscus coeruleus, Dracena indivisa,** egg plant, ferns (Boston), **Ficus elastica,** freesia, fuchsia, gardenia, geranium, gladiolus, heliotropium, hydrangea, **Impatiens sultana,** ivy (English), larkspur, lantana, **Lilium giganteum,** myosotis, nasturtium, cattleya, cypripedium, laelia, kentia, pandanus, parsley, peach, pelargonium, pepper, petunia, **Primula obconica,** rose, salvia, schizanthus, **Vinca rosea, Vinca variegata,** wallflower.

Description of Calcium Cyanide. Calcium cyanide is a dark gray solid, resembling calcium carbide in many ways, and is found on the market in flake, granular and powdered form. Upon exposure to the air calcium cyanide undergoes a change, liberating hydrocyanic acid in the form of a gas and leaving a colored residue which is mostly lime. The hydrocyanic acid liberated is the killing agent, and when used in sufficient concentration it is a deadly poison to both men and other animals. There is a slight amount of acetylene gas given off at the same time, the odor of which serves as an indicator of the presence of the other gas.

Dosage to Use and Methods. Much attention must be given to the correct amount of the material to use to each 1000 cubic feet of greenhouse space. As has been stated, damage to the plants and serious loss will result if an overdose is used. The following points must be followed if loss is to be avoided and the insects killed.

SIX POINTS WHICH MUST BE OBSERVED

1. Calculate accurately the cubic space in your greenhouse (See page 6)

2. Be sure your house is free from plants which are especially susceptible to injury from fumes of cyanide (See page 5)

3. Accurately weigh out the amount of material needed. Start with one-eighth (⅛) ounce to 1000 cubic feet. If your house is fairly tight this dosage will be quite enough. (See page 7)

4. Always start the fumigation about one hour after sundown—never before. Choose a still night.

5. Do not water the greenhouse for at least twenty-four hours before fumigation.

6. The temperature should be between 55 and 70 degrees Fahr., and it should be a rising rather than a falling temperature. Falling temperatures produce moisture which collects on the plants and makes them more susceptible to injury.

SIX ESSENTIALS IN CYANIDE FUMIGATION

Calculation of Cubical Air Space in the Greenhouse. To calculate the number of cubic feet in a greenhouse the width is multiplied by the length and this by the average height. To get the average height add the lowest height and the highest height together and divide by two. To illustrate: If a house is six feet high at the lowest part when viewed from the end, and ten feet high

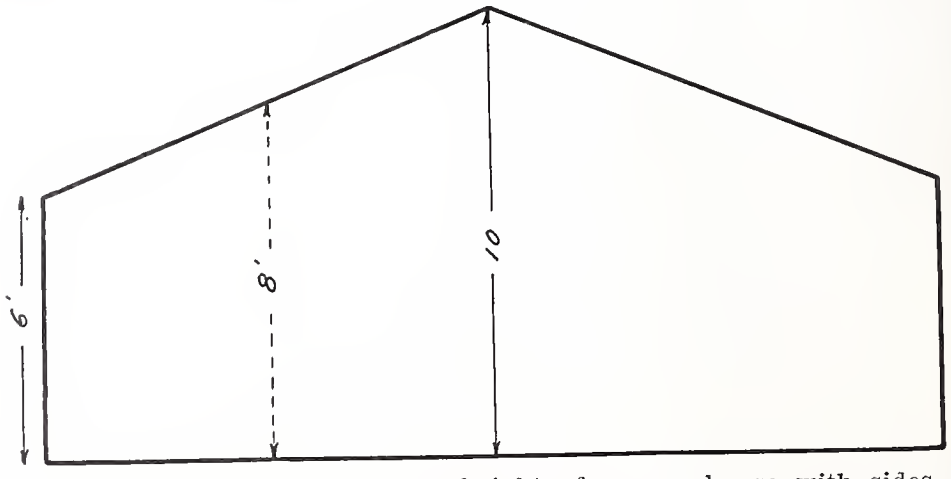


Fig. 1. Plan for getting average height of a greenhouse with sides of the same height

at the highest point when so viewed, the average height would be eight feet. (See Fig. 1)

Houses which have uneven heights on either side of the center may be calculated by finding the average height for each side and considering each side as separate houses for convenience of calculations. (See Fig. 2)

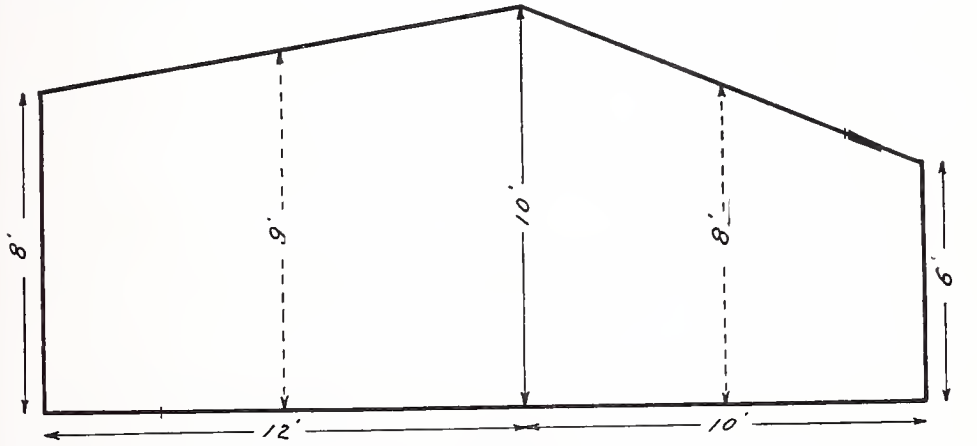


Fig. 2. Plan for getting cubical contents of a greenhouse with sides of uneven height

Preparing the Dose. Do not guess as to the required amount of material needed, make careful weighings wherever possible. After the required amount is weighed out, divide into several lots. To apply, simply scatter the material on the walks of the greenhouse. (See cover page). The material should be evenly distributed over the length of the walks of the house in order to get an even distribution of the gas. Only the center walk need be used in houses of 40 feet or less in width. Use two or more walks in wider houses.

Amount to Use: As stated before begin by using one-eighth (⅛) ounce to each 1000 cubic feet for the first fumigation. If this gives a kill, future fumigations should be with ⅛ ounce to each 1000 cubic feet. If the kill is not complete, increase the amount to one-fourth (¼) ounce to each 1000 cubic feet. The tightness of the greenhouse is the reason for failure or success with the one-eighth ounce charge.

Time and Duration of Exposure. It has long been known that fumigation with hydrocyanic acid in greenhouses in daylight is accompanied by heavy loss to the plants so treated. Since the killing agent in calcium cyanide is hydrocyanic acid the usual night-time fumigation should be followed. The charge should be placed soon after sundown and the house kept closed until the following morning. A still night should be chosen since less gas

will be lost from the greenhouse due to wind and circulation of the air.

After the cyanide has been placed on the walks leave at once and close the doors.

After a few hours the concentration of the gas is slight, and some growers enter the house once or twice during the night to observe the thermometers to guard against a fall of temperature. Airing is not necessary the following morning because of the weakness of the concentration, and most of the gas will have been dissipated.

Temperature and Moisture. The presence of moisture on plants increases the likelihood of injury to them when fumigated with hydrocyanic acid. There is always enough moisture present in a greenhouse to bring about the liberation of the gas from the calcium cyanide, hence there is no need to add more on this account. The temperature should be between 55 and 70 degrees Fahr., and should be maintained at an even temperature since falling temperatures produce moisture, thus producing a condition favorable for injury.